Technical Appendix 5.5: Aviation Lighting Assessment

Technical Appendix 5.5: Aviation Lighting Impact Assessment

5.5.1 Introduction

5.5.1.1 This Technical Appendix describes the assessment of effects of aviation obstacle lighting associated with the Proposed Development. The focus of the assessment is on the effects of lighting on visual amenity and, where relevant, the Special Landscape Qualities (SLQ) of designated landscape and Wild Land Qualities (WLQ) of Wild Land Areas (WLA).

5.5.1.2 Daytime visualisations have been provided for all viewpoints. Three representative visualisations have been provided to illustrate the effects of the reduced intensity aviation lighting on the Proposed Development during the hours of darkness for Viewpoints 3: Loch Glass Wyvis Lodge, 4: Strath Rusdale, 7: Minor Road Inchlumpie and 16: Ben Wyvis Lower Summit of An t-Socach (see **Figures 5.28i, 5.29i, 5.32i and 5.41i (EIAR Volume 3b)**). Turbines to be lit are highlighted in blue and numbered in the night photography wirelines. These turbines are shown lit in the photomontages during the hours of darkness.

5.5.2 Regulatory Requirements for Aviation Obstacle Lighting and Assessment Implications

5.5.2.1 Article 222 (1) of the Air Navigation Order 2016 and Regulations (ANO)[1] states an: "en-route obstacle' means any building, structure or erection, the height of which is 150 metres or more above ground level, but it does not include a building, structure or erection:

- which is in the vicinity of a licensed aerodrome; and
- to which section 47 of the Civil Aviation Act 1982 (warning of presence of obstructions near licensed aerodromes) applies."

5.5.2.2 These provisions mean that structures of 150 m or more in the UK are routinely lit with medium intensity (2,000 candela) steady red lights.

5.5.2.3 ANO Article 222 also contains provisions allowing for exemptions from its lighting requirements. Article 222 (6) provides that: "*A permission may be granted for the purposes of this article for a particular case or class of cases or generally*."

5.5.2.4 While Article 222 (7) states: "This article does not apply to any en-route obstacle for which the CAA has granted a permission to the person in charge permitting that person not to fit and display lights in accordance with this article."

5.5.2.5 The Proposed Developments turbines would have a maximum blade tip height of up to 180 m above ground level. Therefore, they would normally be subject to the lighting requirements set out in Article 222 (1). However, the provisions in the CAA Policy Statement[2] that the intermediate-level lights are only required to be low intensity (32 candela) and that the intensity of the 2,000 candela light may be reduced to 10% of its peak intensity, "if the horizontal meteorological visibility in all directions from every wind turbine generator in a group is more than 5 km."

5.5.2.6 The technical specifications for medium intensity obstacle lights are set out in International Civil Aviation Organisation (ICAO) Code - Annex 14[3] Table 6-3 and, for European Union Aviation Safety Agency (EASA) member states such as the UK, in Table Q-3 of CS-ADR-DSN[4]. The ICAO and EASA specifications are identical.

5.5.2.7 The ICAO and EASA specifications for lighting do not use the term "minimum peak intensity" set out in paragraph 4.6j. of the CAA Policy Statement. The required and recommended intensity settings for 2,000 candela lights are illustrated in **Figure 5.5.1** and summarised as follows:

- Minimum average intensity between 0 and -3 degrees is 2,000 candela;
- Between 0 and -1 degrees intensity would reduce from 2,000 to 750 candela;
- Between -1 and -2 degrees intensity would reduce to from 750 to 80 candela;
- Between -2 and -3 degrees intensity would reduce from 80 to 40 candela; and
- Between -3 and -4 degrees intensity would reduce from 40 to 0 candela.

5.5.2.8 The implications of this for visibility of the lights from key viewpoints is that, depending upon the angle of receptors relative to the turbine lights, the intensity of light will vary, along with its perceived brightness. For example, for a light with a maximum intensity of 2,000 candela, views from below -3 degrees would see the light source as below 40 candela, a considerable reduction in perceived brightness from the maximum intensity, and if receptors view the light from below -4 degrees there would, theoretically be no direct view of the light.

5.5.2.9 However, depending upon the specification and design of the light, some light reflection off the back of turbine blades may be discernible.

5.5.2.10 In conditions where horizontal meteorological visibility exceeds a 5 km radius from the position of the light significant reductions in light intensity would be experienced, as lighting intensity would be reduced to 10% of the maximum intensity, as summarised below.

- Minimum average intensity at 10% between 0 and -3 degrees would be 200 candela;
- Between 0 and -1 degrees intensity would reduce from 200 to 75 candela;
- Between -1 and -2 degrees intensity would reduce to from 75 to 8 candela;
- Between -2 and -3 degrees intensity would reduce from 8 to 4 candela; and
- Between -3 and -4 degrees intensity would reduce from 4 to 0 candela.

5.5.2.11 Consequently, receptors located over 5 km from the turbines would only ever experience clear visibility to lights at these reduced intensities. In conditions of meteorological visibility less than 5 km the perceived brightness of turbine lights, whilst possibly still visible, are likely to be reduced by such conditions. Additionally, when combined with local sources of light (including internal and/or external lighting and car lights) such as those present along the A9 and A835 corridors and in the settled landscapes at and around Inverness, the Black Isle and the Cromarty and Moray Firths the impact of the turbine lighting on such distant receptor locations may decrease to slight or even negligible magnitude.

[1] Statutory Instrument 2016 No. 765 The Air Navigation Order 2016

[2] UK Civil Aviation Authority (2025) CAA Policy and Guidelines on Wind Turbines CAP 764

[3] International Civil Aviation Organisation (2022) Annex 14 to the Convention on International Civil Aviation Aerodromes Volume 1 Design and Operations

[4] European Union Aviation Safety Agency (2025) Certification Specifications and Guidance Material for Aerodrome Design (CS-ADR-DSN)

5.5.3 Assessment Methodology

Guidance

5.5.3.1 The following assessment takes cognisance of NatureScot's Guidance[5] on Aviation Lighting Impact Assessment and is consistent with the broader LVIA methodology provided in **Chapter 5 (EIAR Volume 2)**. In accordance with NatureScot's guidance, the assessment comprises the following steps:

- Step 1: A definition of the lighting proposals for the Proposed Development;
- Step 2: A description of the baseline landscape and visual context; and
- Step 3: An assessment of the effect of Proposed Development's aviation lighting on the landscape and visual resource.

5.5.3.2 The assessment is supported by Aviation Lighting ZTV (**Figures 5.5.1**) and visualisations showing both the two lighting scenarios described below i.e. a scenario with all turbines lit and a scenario with only turbines 1, 5, 7 and 9 lit. Night-time visualisations are shown for the following viewpoints in **EIAR Volume 3b**:

- Viewpoint 3: Loch Glass, by Wyvis Lodge (**Figures 5.28h-i**);
- Viewpoint 4: Strath Rusdale (**Figures 5.29h-i**);
- Viewpoint 7: Minor Road at Inchlumpie (**Figures 5.32h-i**); and
- Viewpoint 16: Ben Wyvis Lower Summit of An t-Socach (**Figures 5.41h-i**).

5.5.4 Step 1: Lighting Proposals

Lighting Proposals

5.5.4.1 From a CAA perspective the Proposed Development is sited outside controlled airspace and 30 km from Inverness airport. As a result, it will be assessed against visible lighting in accordance with Class G 'en-route' airspace requirements as detailed in CAP 764 (latest draft). The following factors have been taken into account:

- To accommodate Ministry of Defence (MoD) requirements the Site will be assessed for Night Vision Goggles (NVG) compatible lighting in accordance with MoD published obstruction lighting specifications;
- Where possible the recommended final lighting configuration will be optimised to reduce light impact on the local area; and
- CAA obstruction lighting dispensations that are currently offered where flight safety can be maintained will be included.

5.5.4.2 In accordance with the CAP 764 (draft) conditions, the CAA requires:

- That all perimeter turbines be lit unless removing a light will leave a gap of less than 900 m total between the remaining lit turbines;
- That any turbine within 200 m of a 'string perimeter' be lit unless the distance between adjacent turbines is less than 900 m total. Additional spacing dispensation is sometimes available for the above criteria;
- That any unlit turbine does not exceed a 10° up-slope from adjacent lit turbines; and
- No turbine shall be more than 1,800 m (1 Nautical Miles (nm)) from a lit turbine.

5.5.4.3 Applying these criteria dictates that all nine of the Proposed Development turbines would require ANO visible red lighting. However, as stated in **Chapter 12 (EIAR Volume 2)** a reduced lighting scheme has been designed resulting in only four visible steady red lights being required for the Proposed Development (turbines 1, 5, 7 and 9). This has been agreed by the CAA as per **Chapter 12 (EIAR Volume 2)**.

5.5.4.4 Aviation lights would be fitted on the nacelles of the selected turbines and would be located at around 99 m above ground level.

5.5.4.5 Whilst all nine of the Proposed Development's turbines would require infrared lights to meet the MoD requirements such lighting is not visible to the naked eye and has therefore not been considered further in this assessment.

Mitigation

5.5.4.6 There are principally five current sources of potential mitigation in respect of aviation lighting on turbines, comprising four technological (in addition to one inherent) which have been introduced and accepted to varying degrees by aviation authorities in countries around the world (including by the United States Federal Aviation Authority ('FAA'), German Federal Aviation Office ('LBA'), and the Netherlands Aerospace Centre ('NAC'):

- The reduction in lighting intensity during periods of meteorological visibility in excess of 5 km (as discussed previously);
- The inherent reduction in apparent light intensity from source and size of light when viewed over distance.
- The reduction in lighting intensity for receptors at different elevations relative to source, as a result of design of the lights;
- The design of the lights to avoid illumination of turbine nacelles, towers, and blades; and
- The lighting of only certain turbines along the perimeter of the wind farm, thereby limiting the number of lights visible at any given location, as outlined previously.

Reduced Lighting Intensity Over Distance

5.5.4.7 As observed during field reconnaissance, the perceived brightness and size of the light source, as experienced at different locations, will vary according to distance and atmospheric conditions. The intensity and brightness of the visible light, whilst constant in actuality, reduces as distance increases, due primarily to a reduction in the size of the lights surface and light energy reaching receptors. Clearly, any water droplets or air borne particles compounds this effect, partially or entirely obscuring the light source.

Reduced Lighting Intensity by Relative Elevation

5.5.4.8 **Figure 5.5.1** illustrates the intensity of turbine lights at different locations across the LVIA Study Area taking account of the angle at which they are seen from receptor locations. It is apparent from this figure that the greatest intensity and brightness experienced would occur at elevated locations which are infrequently visited after dark, whilst considerable reductions in intensity and brightness would be witnessed from low lying locations close by to the turbines, at primary visual receptor locations.

[5] NatureScot (2024) Guidance on Aviation Lighting Impact Assessment

Lighting Design

5.5.4.9 The degree of mitigation achieved through careful design of lights is crucial. Lights on the side of towers can be designed to minimise illumination of the tower, however it is assumed these are not required for the Proposed Development. Similarly, the incorporation of light caps and collars can restrict up-lighting effects and the degree of downlighting and illumination of the nacelle of the turbine. In the case of the Proposed Development these are not required given the location of the proposed turbines.

5.5.4.10 Light intensity will vary according to the manufacturer of the lights. As a manufacturer has not yet been selected the assumptions on light intensity reduction are based on the recommended intensity settings described in Section 1.2. The visualisations shown on Figures 5.28h-i, 5.29h-I, 5.32h-i and 5.41h-I show worst case scenario with 2,000 cd lights without directional intensity mitigation.

5.5.5 Step 2: Baseline Context

Landscape Character

5.5.5.1 **Technical Appendix 5.2 (EIAR Volume 4)** describes the landscape character types (LCTs) considered elsewhere in the LVIA and describes the sensitivity of each landscape to the type of development proposed. **Figure 5.3 (EIAR Volume 3a)** shows the location the LCTs.

5.5.5.2 It is noted that NatureScot's character descriptions do not discuss night character. Whilst a number of landscape characteristics may be evident during periods of low ambient light levels (including dusk), it is also the case that perceived brightness of turbine lights would be lessened during such times of day, the greatest potential for significant effects would occur after dark. Of the 'daytime' characteristics described it is only visual aspect of the wild and remote characteristics that are of the most relevance to the assessment of aviation lighting, especially in respect of elevated uplands, including:

- LCT135: Rounded Hills – Caithness and Sutherland;
- LCT139: Rugged Mountain Massif – Caithness and Sutherland;
- LCT328: Rounded Mountain Massif – Ross & Cromarty;
- LCT330: Rounded Hills and Moorland Slopes – Ross and Cromarty (in which Strathrory wind farm introduces a noticeable artificial light source to this landscape); and
- LCT331: Rounded, Rocky Hills – Ross and Cromarty.

5.5.5.3 These landscapes are essentially dark, largely uninhabited, and relatively difficult to access with limited incidence of artificial lighting with the exception of some scattered farmsteads and dwellings on lower slopes adjoining straths, lochs, and farmed landscapes and/or where roads bisect these LCTs. There are operational wind farms in LCT329 and LCT330 and, with the exception of Strathrory wind farm (three of which are lit), none have visible aviation lighting.

5.5.5.4 Key receptors within these LCTs comprise hill walkers, a small number of which may camp overnight at summits and value the dark and remote nature of such locations.

5.5.5.5 There are also secluded valley landscapes within 20 km including:

- LCT339: Inland Strath; and
- LCT340: Strath – Ross and Cromarty.

5.5.5.6 These landscapes are enclosed and sparsely settled with sources of light limited to those associated with dwellings and farms. These landscapes are dark and easier to access than the surrounding uplands which form a backdrop to outward views.

5.5.5.7 Contrasting with the upland landscapes and secluded valleys there are settled and farmed landscapes of the lower hillslopes and coastal margins of the Cromarty Firth to the south and east and the Dornoch Firth to the north. Light sources are present in these landscapes and include intense light sources at dense urban areas such as Strathpeffer, Dingwall, Alness, Invergordon and Culbokie. Traffic moving along the A9 and A835 are notable sources of light visible from longer distances. The Mounteagle mast on the Black Isle is a notable landmark on which there are five steady red aviation lights. The lights on the mast are visible from the surrounding area. There are point sources of intensive light along the coast of the Cromarty Firth, particularly at Invergordon where marine industrial activity is present. The skylines visible from these more open coastal areas is largely dark. There is a single turbine 67 m to tip at Foulis Mains farm to the west of the A9 which has a red flashing light rated at 32cd. Three turbines at Strathrory wind farm have steady 2,000cd lights on each nacelle.

5.5.5.8 NatureScot's National Landscape Character Assessment (2019) provides a description of landscape character types (LCT) in Scotland and their key characteristics. The description of LCTs is based on how Scotland's landscape's are perceived during daylight hours. During hours of darkness the perceived character of the landscape would be different to that described by NatureScot for daylight hours. As there is no published description of night-time landscape character this Technical Appendix focusses on changes to views and visual amenity and the effects of aviation obstacle lighting on landscape character are not consider further in this assessment.

Landscape Designations and Classifications

NATIONAL SCENIC AREA (NSA): DORNOCH FIRTH

5.5.5.9 **Technical Appendix 5.4 (EIAR Volume 4)** lists the special qualities of the NSA based on NatureScot's 'Special qualities of the National Scenic Areas: NatureScot Commissioned report No. 374' Of the qualities described, the most relevant to the Aviation Lighting Impact Assessment is the wilder backdrop of hills and moors described by NatureScot as sweeping *"…round to provide an undulating backdrop to the green and fertile alluvial lands. This horizon of wilder hills contrasts markedly with the mosaic of farms and woods on the coastal flats – which comes across as an ordered, long-inhabited land."*

5.5.5.10 This special quality points to a landscape where habitation is present with an ordered pattern to the landscape resulting from a long history of agriculture and settlement. This landscape is experienced against the backdrop of uninhabited, open and wilder hills beyond the NSA. where artificial light sources are rare. However, aviation lights on Strathrory wind farm may be discernible. Visibility of Strathrory would occur at distances of 5-10 km at Dornoch Bridge and in the north of the NSA. Views of lights of the proposed turbines would be distant and concentrated on elevated sections of the NSA with the potential to influence the perceived contrast between the *"Inhabited surrounds within a wilder backdrop of hills and moors"*.

5.5.5.11 The NatureScot description of SLQ is based on the perception and experience of the NSA during daylight hours. The experience and perception of the landscape at night is not described for any SLQ of Dornoch Firth NSA. However, this assessment acknowledges that an appreciation of views and visual amenity during hours of darkness may influence the experience of the SLQ "Inhabited surrounds within a wider backdrop of hills and moors." Night-time effects on Dornoch Firth NSA are therefore considered further in this assessment in relation to this SLQ. None of the other SLQ of Dornoch Firth NSA would be affected.

SPECIAL LANDSCAPE AREA (SLA) 17: BEN WYVIS

5.5.5.12 The Highland Councils (THC) 'Assessment of Highland Special Landscape Areas' sets out the special qualities of this SLA. Of the qualities described, the most relevant to the Aviation Lighting Impact Assessment include:

- "Standing well above a surrounding range of much lower foothills, Ben Wyvis has a commanding presence with its broad and fairly level summit ridge stretching more than 7 km from Garbat to Loch Glass. It is a dominant landmark feature from many locations, most notably from the south and northwest, including Inverness and the Black Isle. Little Wyvis also appears prominent at a local level;
- The summit of Ben Wyvis provides some of the most extensive panoramas in Scotland. These include the wild and dramatic mountain profiles of Wester Ross and Sutherland to the north and west, the indented coastline and settled, fertile lowlands of Easter Ross and the Black Isle to the east, and the distant summits of the Cairngorms and Ben Nevis to the south;
- Views of the top and the overall profile of the mountain are limited from the immediate surroundings, due to its massive scale and convex upper slopes. The form of the mountain is most clearly appreciated when viewed from a distance, for example from Inverness and the Black Isle;
- Ben Wyvis is a popular Munro due in part to its proximity to Inverness but also because it is a relatively straightforward walk with a broad, easy ridge from which the panoramic views can be appreciated. It is also popular for cross-country skiing; and
- With the exception of Wyvis Lodge, the odd shieling hut, and the very occasional boundary wall and rough track there is virtually no visible evidence of human occupation in the SLA."

5.5.5.13 These special qualities point to a largely dark landscape where artificial light sources are rare. However, views of settlements along the Cromarty Firth, on the Black Isle and at Inverness and visibility of traffic using the A9 and A835 interrupt this quality. Aviation lighting on Strathrory wind farm is a new light source in views from elevated locations within the SLA.

SLA 18: FANNICHS, BEINN DEARG AND GLEN CALVIE

5.5.5.14 The Highland Councils (THC) 'Assessment of Highland Special Landscape Areas' sets out the special qualities of this WLA. Of the qualities described, the most relevant to the Aviation Lighting Impact Assessment include:

- "The wide extent of the mountain ranges, limited access routes, rough ground and uninhabited character combine to create a great sense of wildness within an expansive, mountain vastness; and
- Small areas of clear human habitation, vast areas where there is none. The majority of human interaction within the landscape is centred around the River Broom in Strath More, at the western extents of the SLA."

5.5.5.15 The experience and perception of the landscape at night is not explicit in the description of these special qualities. However, views of settlement around the River Broom and Strath More influence this views during the hours of darkness and the proposed lights may also influence the perceived uninhabited character described in these SLQ.

WILD LAND AREA (WLA) 29: RHIDDOROCH – BEINN DEARG – BEN WYVIS

5.5.5.16 **Chapter 5 (EIAR, Volume 2)** lists the wild land qualities of this WLA (based on NatureScot's descriptions). Of the qualities described, the most relevant to the aviation lighting impact assessment are the WLAs very large interior with a strong sense of remoteness, sanctuary, solitude, and isolation.

5.5.5.17 Whilst the WLA description provided by NatureScot does not make reference to night characteristics, it is acknowledged that the essentially dark condition of this WLA at night and general absence of artificial light sources contributes to its perceived wildness.

Visual Amenity

5.5.5.18 The principal receptors and sources of artificial light within the landscape include residents of dwellings as well as road users.

5.5.5.19 As noted above the lower hillslopes, coastal areas and the Black Isle are well settled with larger settlements including Dingwall and Alness between which are numerous villages and scattered residential properties. Artificial light sources are prevalent in these areas and contrast with the darker secluded valleys and uplands. Residential receptors within potential to experience significant effects of aviation lighting are those within approximately 10 km since light intensity decreases with distance. The main residential receptors closest to the Proposed Development (within 10 km) are:

- Dingwall: a town at the head of the Cromarty Firth;
- Strathpeffer: a village set within a wooded valley to the west of Dingwall;
- Maryburgh: a village at the head of the Cromarty Firth to the south of Dingwall;
- Evanton: a village on the north side of the Cromarty Firth;
- Alness: a town to the east of Evanton;
- Strath Rusdale (including Inchlumpie): a community of scattered residential properties and farms in a valley to the northeast of the Site; and
- Boath: a community of scattered residential properties and farms to the northeast of the Site.

5.5.5.20 In the towns and villages there are a number of artificial light sources including interior lighting, street lighting and vehicle lights between the settlements on the A9, A835 and A862 which are the main routes through the area.

5.5.5.21 Key roads that are both receptor locations and sources of artificial light after dark comprise:

- The A9: A busy road that is lit at the junction with the A862 and where it passes through settlements;
- The A835: An unlit road that runs between Maryburgh and Ullapool passing to the south of the Site on the lower valley slopes; and
- The A862: A largely unlit road that passes between the junction with the A9 at the Cromarty Bridge and Dingwall.
- Minor local access roads, which are unlit and generally dark, but subject to the intermittent influence of lighting at scattered properties and from vehicles on other nearby roads.

5.5.5.22 Vehicles moving on roads can be noticeable features in what is otherwise a largely dark strath landscape but are low-lying and intermittent sources of impact.

5.5.5.23 The experience of the night landscape and views from vehicles is affected by dashboard lights and headlight beams, thereby lessening the perceived darkness of the adjacent landscape substantially reducing the likelihood of the proposed turbine lights being visible unless passing nearby. The perception of road users is also transitory, and of limited duration in comparison to that of residents of dwellings.

5.5.5.24 Much of the Study Area comprises remote uplands. These areas are typically devoid of artificial lighting. However, the number and frequency of visual receptors' present on elevated summits is likely to be relatively low and generally restricted to small number of wild campers.

Visibility and Intensity of Lights

5.5.5.25 According to the analysis presented in **Figure 5.5.1** the greatest theoretical light intensity and perceived brightness would be experienced at a number of elevated locations, including:

- Beinn Dearg summit (Viewpoint 1) which is around 28.5 km to the west of the Site and is located at an elevation of 1,084m AOD (**Figure 5.26a-g, EIAR Volume 3b**);
- Carn Salachaidh summit (Viewpoint 2) which is around 14.2 km to the north of the Site at an elevation of 649m AOD (**Figure 5.27a-g, EIAR Volume 3b**);
- Beinn Tharsuinn summit (Viewpoint 10) which is 8.8 km to the northeast of the Site at an elevation of 692m AOD (**Figure 5.35a-g, EIAR Volume 3b**);
- Ben Wyvis (Viewpoint 16) which is 8 km to the southwest of the Site at an elevation of 1,046m AOD (**Figure 5.41a-i, EIAR Volume 3b**);
- Tom Ban Mor summit (Viewpoint 22), approximately 21.7 km west of the Site at an elevation of 742m AOD (**Figure 5.47a-g, EIAR Volume 3b**); and
- Diebidale Ridge (Viewpoint 23), approximately 14.5 km to the north-west of the Site at an elevation of 691m AOD (**Figure 5.48a-g, EIAR Volume 3b**).

5.5.5.26 These locations are over 5 km from the Site and so the maximum intensity of light that would be experienced in clear meteorological conditions would be 200 candela. Several of these viewpoints are over 15 km from the Proposed Development and therefore subject to further mitigation due to distance; distant aviation lights appear as small points of light within what are generally expansive views. It is also the case that these receptor locations are infrequently visited after dark.

5.5.5.27 From some elevated locations, the Proposed Development may be seen in the context of operational Strathrory wind farm which establishes aviation lighting as a feature of the upland landscape approximately 10 km northeast of the Proposed Development. In this context the Proposed Development's lighting would not represent a wholly new feature in the night landscape.

5.5.5.28 Lower lying positions, in contrast, would be subject to limited or no views of turbine lights and lower degrees of brightness and intensity, turbine lights often being obscured by intervening topography and/or vegetation. Views from such low-lying positions are illustrated at:

- Loch Glass (Viewpoint 3) which is located around 4.8 km west of the Site at an elevation of 240m AOD (**Figure 5.28a-i, EIAR Volume 3b**);
- Strath Rusdale (Viewpoint 4) which is 5.7 km to the north of the Site at an elevation of 190m AOD (**Figure 5.29a-i, EIAR Volume 3b**);
- A9 between Duncaston and Causeway (Viewpoint 5) which is located approximately 13.6 km south of the Site at an elevation of 100m AOD (**Figure 5.30a-g, EIAR Volume 3b**);
- Boath (Viewpoint 6) which is approximately 2.6 km to the north of the Site at an elevation of 180m AOD (**Figure 5.31a-g, EIAR Volume 3b**);
- Minor Road to Inchlumpie (Viewpoint 7) which is 4.5 km to the north of the Site at an elevation of 185m AOD (**Figure 5.32a-i, EIAR Volume 3b**);
- Minor road by Ardross Distillery (Viewpoint 8) which is 5.5 km to the northeast of the Site at an elevation of 140m AOD (**Figure 5.33a-g, EIAR Volume 3b**);
- Loch Morie (Viewpoint 9) which is 4.3 km to the north of the Site at an elevation of 195m AOD (**Figure 5.34a-g, EIAR Volume 3b**);
- Summit of Cnoc Fyrish, (Viewpoint 11) which is 4.8 km to the southeast of the Site at an elevation of 453m AOD (**Figure 5.36a-f, EIAR Volume 3b**);
- Cromarty, Black Isle (Viewpoint 12), which is located around 22.7 km to the east of the Site at an elevation of 0m AOD (**Figures 5.37a-g, EIAR Volume 3b**);
- Easter Brae, Black Isle (Viewpoint 13) which is 13.5 km to the southeast of the Site at an elevation of 140m AOD (**Figure 5.38a-g, EIAR Volume 3b**);
- Dornoch Point (Viewpoint 14), which is located around 29 km to the northeast of the Site at an elevation of 0m AOD (**Figure 5.39a-f, EIAR Volume 3b**);
- Dornoch Firth Bridge (Viewpoint 15), which is located around 23.7km to the northeast of the Site at an elevation of 15m AOD (**Figures 5.40a-f, EIAR Volume 3b**);
- A835 at Leanaig Junction (Viewpoint 17) which is 17.2 km to the south of the Site at an elevation of 110m AOD (**Figure 5.42a-g, EIAR Volume 3b**);
- B9039 Approach to Ardersier (Viewpoint 18) which is located around 28 km to the southeast of the Site at an elevation of 10m AOD (**Figure 5.43a-g, EIAR Volume 3b**);
- Culbokie, Black Isle (Viewpoint 19) which is located around 12.5 km to the south of the Site at an elevation of 90m AOD (**Figure 5.44a-g, EIAR Volume 3b**);
- Glen Glass (Viewpoint 20) which is located around 2.4 km to the west of the Site at an elevation of 240m AOD (**Figure 5.45a-h, EIAR Volume 3b**);
- A817, Invergordon (Viewpoint 21) which is located around 13.5 km to the east of the Site at an elevation of 0m AOD (**Figure 5.46a-g, EIAR Volume 3b**);
- Knockfarrel (Viewpoint 24) which is located around 13.4 km to the south of the Site at an elevation of 218m AOD (**Figure 5.49a-g, EIAR Volume 3b**);
- A862 at Lentran (Viewpoint 25) which is located around 25.8 km to the south of the Site at an elevation of 50m AOD (**Figure 5.50a-g, EIAR Volume 3b**);
- A96 between Nairn and Inverness Retail Park (Viewpoint 26) which is located around 28.4 km to the south of the Site at an elevation of 20m AOD (**Figure 5.51a-g, EIAR Volume 3b**);
- Sutors of Cromarty (Viewpoint 27) which is located around 24.6 km to the east of the Site at an elevation of 50m AOD (**Figure 5.52a-g, EIAR Volume 3b**);
- A9 east of Alness (Viewpoint 28) which is located around 16.7 km to the east of the Site at an elevation of 10m AOD (**Figure 5.53a-g, EIAR Volume 3b**);
- Viewpoint Tower at Inverness Castle (Viewpoint 29), located approximately 28.3 km south of the Site at an elevation of 55m AOD (**Figure 5.54a-g, EIAR Volume 3b**); and
- Ardross Community Hall (Viewpoint 30) which is located around 8.3 km to the east of the Site at an elevation of 180m AOD (**Figure 5.55a-g, EIAR Volume 3b**).

5.5.5.29 Much of the coast and interior of straths and glens where settlement and transportation routes occur would not be affected by the Proposed Developments turbine lighting due to the screening effect of intervening topography and/or vegetation, as evidenced by Viewpoint 7 (**Figure 5.32 a-i, EIAR Volume 3b**).

5.5.6 Step 3: Aviation Lighting Effects on Landscape and Visual Resource

Effects on Landscape Designations and Classifications

NSA: Dornoch Firth

5.5.6.1 Analysis of the Aviation Lighting ZTV **Figure 5.5.1** indicates that views of lights on the Proposed Development would be theoretically possible in the northern part of the NSA, to the north of Dornoch

Bridge. Much of the theoretical visibility would be screened by woodland. Viewpoint 14: from Dornoch Point (**Figure 5.39a-f, EIAR Volume 3b**) illustrates that the turbines would be screened by the forestry on the hilltops south of the Firth. When visible, light intensity of any aviation lights visible would be further reduced by distance, constituting a Minor effect (Not Significant) effect on the special landscape quality of "Inhabited surrounds within a wilder backdrop of hills and moors" of the NSA. Given the limited influence on a single SLQ, the small extent of the designation affected and the distance at which the lights would be seen, the effect on the contrast and backdrop provided by the hills is not expected to be significant and the integrity of the designation would not be undermined.

SLA 17: Ben Wyvis

5.5.6.2 Analysis of the Aviation Lighting ZTV **Figure 5.5.1** indicates theoretical visibility of lights on the proposed turbines from the northeast facing slopes and a small number of peaks and ridges on the plateau, including the lower summit, An t-Socach (see Viewpoint 16: Ben Wyvis Lower Summit of An t'Socach **Figures 5.41h-i**). At these locations there is no potential for significant effects on the SLQ of views of "extensive panoramas" from the summit of Ben Wyvis within the SLA. The "extensive panoramas" SLQ is experienced during daylight hours. While the Proposed Development would introduce a notable new light source to an essentially dark outlook, the proposed lights would not interrupt the "dramatic mountain profiles of Wester Ross and Sutherland or the "distant summits of the Cairngorms and Ben Nevis" which are notable feature of views described for this SLQ. The proposed lights would be seen in conjunction with "the indented coastline and settled, fertile lowlands of Easter Ross". However, during hours of darkness the scenic qualities of this aspect of the SLQ would not be readily discernible and the proposed lights would be seen against a backdrop of existing artificial sources of light in these coastal and settled areas.

5.5.6.3 Effects would be Moderate/Minor and not significant and limited to the summit of Ben Wyvis and a small number of summits within 10 km of the Proposed Development introducing new lights in addition to those light sources associated with Strathrory Wind Farm which would be visible behind the Proposed Development. The summit of Ben Wyvis and surrounding summits are potentially visited by a very small number of people during hours of darkness.

5.5.6.4 Given the limited geographical extent of such effects on a single SLQ, and the largely unaffected majority of the SLA and the lit context within which they would be seen, i.e. the lighting from settlements along the coastline, and Strathrory Wind Farm (under construction at the time the LVIA was undertaken), the overall effect on Ben Wyvis SLA is not expected to be significant, and the integrity of the designation would not be undermined.

SLA 18: Fannichs, Beinn Dearg and Glen Calvie

5.5.6.5 Analysis of the Aviation Lighting ZTV **Figure 5.5.1** indicates that views of the Proposed Development's lights would be possible from a very small number of open summits in the SLA including Viewpoint 1: Beinn Dearg (**Figure 5.26a-g, EIAR Volume 3b**), Viewpoint 22: Tom Ban Mor (**Figure 5.47a-g, EIAR Volume 3b**), and Viewpoint 23: Diebidale Ridge (**Figure 5.48a-g, EIAR Volume 3b**). The distance to the SLA is greater than 5 km meaning that, when visible from the SLA, the lights would be in automatic dimming mode and the maximum intensity would be 200 cd. The intensity of the lights would be reduced and the contrast with baseline conditions would lessen. Given the distance to the SLA, the reduced intensity of lights and the small proportion of the view occupied by the Proposed Development effects would be Minor and Not Significant on the perceived uninhabited character of the SLA as evidenced in the two SLQ assessed.

5.5.6.6 Given the limited nature of such effects and the largely unaffected majority of the SLA, and the lit context from parts of the SLA within which they would be seen, the effect on the perceived uninhabited qualities of the SLA are not expected to be significantly affected overall and the integrity of the designation would not be undermined.

WLA 29: Rhiddoroch – Beinn Dearg – Ben Wyvis

5.5.6.7 Analysis of the Aviation Lighting ZTV **Figure 5.5.1** indicates that views of the Proposed Development's lights would be possible from open elevated locations in the WLA including:

- Beinn Dearg (Viewpoint 1);
- Carn Salachaidh (Viewpoint 2);
- Ben Wyvis Lower Summit (Viewpoint 16);
- Tom Ban Mor (Viewpoint 22); and
- Diebidale Ridge (Viewpoint 23).

5.5.6.8 Significant effects (Moderate) would be restricted to a small number of summits within 10 km of the Proposed Development (e.g. Ben Wyvis) from where the Proposed Development would introduce noticeable new lights, adding to the light sources associated with Strathrory Wind Farm. The night-time photomontage from Viewpoint 16: Ben Wyvis Lower Summit of An t-Socach indicates the appearance of the proposed lights during hours of darkness.

5.5.6.9 However, given the small proportion of the WLA affected, and the limited nature of such effects, the effect on the relative wildness of the WLA is not expected to be significantly affected overall and the integrity of the WLA would not be undermined.

Visual Effects

Settlements and residents

5.5.6.10 There is varied settlement pattern in the Study Area including scattered dwellings in the remote straths and glens to well established settlement on the Black Isle and along the coast of the Inner Moray and Cromarty Firths. Within this, visibility is often restricted by the screening effect of intervening topography, buildings and vegetation. A large proportion of settlements and transportation networks would be unaffected by lighting on the Proposed Development, as indicated in **Figure 5.5.1**. Where lights are visible, they would appear elevated and of a reduced brightness. The contrast with baseline would be reduced due to the presence of lighting in the settlements and along transport corridors.

5.5.6.11 **Figure 5.5.1** indicates that of none of the settlements within 5-10 km would have theoretical views of the Proposed Development's lights at higher intensities. Due to directional intensity reduction and automatic dimming, the intensity of lights would be at very low levels and the contrast with baseline would barely be discernible. There would potentially be visibility of lights in the area around Easter Ardross where directional intensity reduction would result in low light intensities as the lights would be in automatic dimming mode and the angle of view would reduce the perceived intensity. There would potentially be visibility of lights in the Ardullie area to the southwest of Evanton. The ZTV shows a notable area of visibility on the north facing slopes of the Black Isle between the A9 and Cullicudden including Culbokie where streetlights are present. The presence of streetlights would reduce the contrast of the proposed lights with the baseline. Darkness adaptation in areas with streetlights would also be a mitigating factor. At these distances the lights would be in automatic diming mode, and the angle of view would be such that perceived intensity would be 75 cd at the most. Effects would not be significant on residents and settlements within 5-10 km.

5.5.6.12 Within 5 km of the Site including parts of Strath Rusdale the lights may be visible when operating in conditions of poor visibility without automatic dimming. During such conditions the lights would be operating at maximum rated intensity. However, the maximum intensity of 2,000 cd would only be

experienced at 0 to +3 degrees from horizontal at the height of the lights i.e. 99 m above ground level. The ZTV on **Figure 5.5.1** shows that lights would not be visible at Boath due to directional intensity reduction. In Strath Rusdale there would be very limited visibility of lights at Braeantra and Ardross in Strath Rusdale. There would be very limited visibility of lights from settled areas within 5 km and where such visibility occurs directional intensity reduction would reduce effects from.

5.5.6.13 Taking this and the restricted visibility of aviation lighting on residential receptors within 5 km of the Site into account (as indicated on **Figure 5.5.1**), the effects of the proposed aviation lighting would not significantly affect residents within settlements and neighbouring communities.

Roads

5.5.6.14 The road network in the Study Area is concentrated within incised straths and along the coast where views of lights on the Proposed Development would be restricted by the screening effect of intervening topography and vegetation. Consequently, a large proportion of the transportation network would be unaffected by the Proposed Development, as indicated in **Figure 5.5.1**. Where lights are visible, they would appear elevated and of a reduced brightness due to automatic dimming and directional intensity reduction. The degree of contrast with baseline would be reduced for road users due to lights on the dashboard of vehicles, headlights of oncoming vehicles, and the tail-lights and brake lights of other traffic.

A9

5.5.6.15 Analysis of the Aviation Lighting **ZTV Figure 5.5.1** indicates that the greatest potential for direct views of the Proposed Development lights would be travelling northbound across the Black Isle, over the highest point, shortly after the junction at Tore. However, this area is heavily wooded and long rage views are screened. Views are likely for a short duration, but they would not constitute a significant effect.

5.5.6.16 The only other section of the A9 from which there are theoretical views of the Proposed Development's lights is west bound from the junction with the B9175 to north of Invergordon. Views towards the Site would be slightly oblique to the direction of travel, and mature trees and hedgerows along field boundaries would largely filter and screen such views, as illustrated in Viewpoint 28: A9 East of Alness (**Figure 5.53a-g, EIAR Volume 3b**).

A835

5.5.6.17 There is one section of the A835 from which there would be views towards the Proposed Development's lights (as indicated by **Figure 5.5.1**). This would occur travelling westbound from just after the junction at Tore to Cononbridge/Maryburgh. Groups of trees and farm buildings would largely filter the Proposed Development along this section of road. There would not be significant effects on this road since a relatively short section of the road would have potential views, and any such views from inside a vehicle would be oblique, restricted and reduced by the influence of internal and external vehicle lights. The remainder of the road would have no views of the Proposed Development from this road.

A862

5.5.6.18 Although this road passes within 10 km of the Proposed Development, it would have no views of the proposed aviation lighting until the section of road around Muir of Ord, some 17 km away. **Figure 5.5.1** show theoretical visibility of lights from the A862 between Inverness and Beauly at distances of greater than 20 km. Given the distance and the well-treed nature of the road corridor around Muir of Ord, there would be no significant effects on this road from lights from the Proposed Development.

5.5.7 Conclusions on the Effects of Lighting

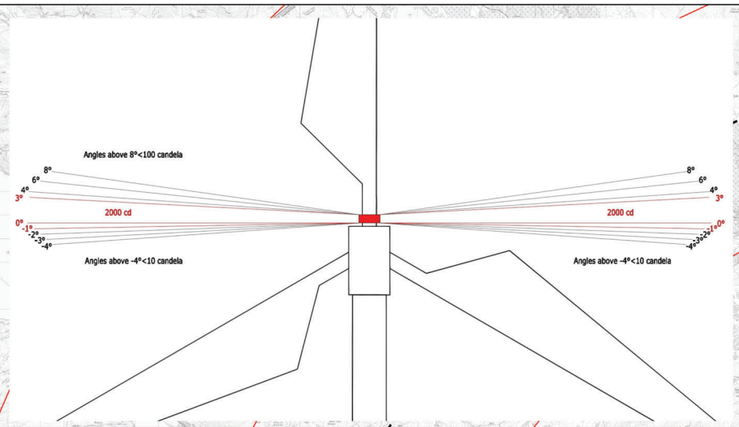
5.5.7.1 The topic of lighting effects is complex and highly nuanced. How the lights which are experienced would depend upon a range of factors from weather and visibility conditions, receptor elevation and distance relative to the Proposed Development, and whether receptors are moving or static.

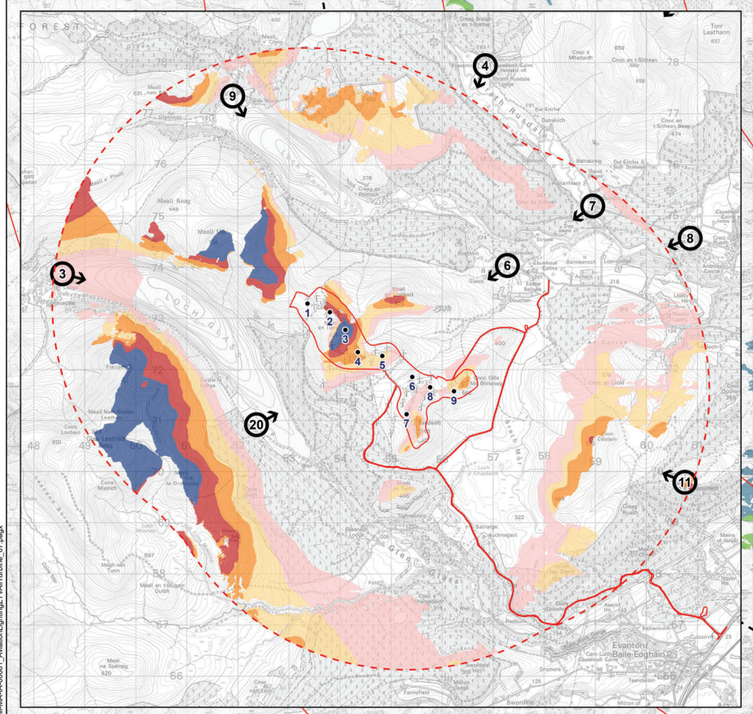
5.5.7.2 The visibility of the lights at the Proposed Development would primarily affect visual receptors in elevated upland landscapes which are unpopulated and seldom visited after dark. The eastern part of the Study Area is influenced by sources of light at settlements, industrial areas, road corridors and the Mount Eagle transmitter on the Black Isle. These sources of light influence to a degree the darker upland areas of the Study Area which lie mainly to the north and west of the Site. With increasing distance to the west, the influence of existing sources of lights diminishes and so too would the effects of lights on the Proposed Development due to automatic dimming and the effects of intervening distance reducing the contrast with baseline conditions. Lights on Strathrory Wind Farm influence the eastern parts of the Study Area to a degree.

5.5.7.3 Views of the lights from lower lying landscapes, settlements and roads would be substantially restricted by intervening topography and vegetation within these areas in the Study Area. Such landscapes also have a lesser degree of perceived remoteness, often containing existing light sources associated with established settlements, scattered farmsteads and dwellings as well as the headlights and interiors of vehicles. Effects in these landscapes would be confined mainly to road users in vehicles on the minor roads within 5 km of the Site where the lights would form notable elevated points of light and new focal points in views. However, car dash-lights and headlights coupled with the transient nature of views from vehicles would lessen the magnitude of impacts arising from the turbine lights.

5.5.7.4 The effects previously presented, represent a reasonable 'worst-case' based on the reduced lighting scheme which has been agreed with CAA.

Figures





10 km

20 km

30 km

0 10 20 km

Legend

- Application Boundary
- Design Freeze Layout - All turbines
- 10 Km Radii from Outer Turbines
- Study Area (5 km from Outer Turbines)
- Study Area (35 km from Outer Turbines)
- Viewpoint

Visibility & Light Intensity (within 5km)

- 0 to 3 (2000 candela)
- 0 to -1 (reducing from 2000 to 750 candela)
- -1 to -2 (reducing from 750 to 80 candela)
- -2 to -3 (reducing from 80 to 40 candela)
- -3 to -4 (reducing from 40 to 0 candela)

Visibility & Light Intensity

- 0 to 3 (200 candela)
- 0 to -1 (reducing from 200 to 75 candela)
- -1 to -2 (reducing from 75 to 8 candela)
- -2 to -3 (reducing from 8 to 4 candela)
- -3 to -4 (reducing from 4 to 0 candela)

ID	Easting	Northing	Title
1	225962	881175	VP1 - Beinn Dearg
2	251843	887408	VP2 - Carn Salachaidh
3	248566	873870	VP3 - Loch Glass, by Wyvis Lodge
4	256846	877942	VP4 - Strath Rusdale
5	259044	858041	VP5 - A9 between Duncanston and Causeway
6	257277	874032	VP6 - Boath
7	258900	875196	VP7 - Minor Road at Inchlumpie - Revised Location due to woodland screening at VP7
8	260859	874565	VP8 - Minor Road by Ardross Distillery
9	251899	877346	VP9 - Loch Morie
10	260649	879274	VP10 - Summit of Beinn Tharsuinn
11	260755	869792	VP11 - Summit of Cnoc Fyrish
12	278585	867679	VP12 - Cromarty, Black Isle
13	266091	863022	VP13 - Easter Brae, Black Isle
14	280467	887656	VP14 - Dornoch Point
15	274771	886435	VP15 - Dornoch Firth Bridge
16	247096	868179	VP16b - Ben Wyvis. Lower Summit of An t- Socach
17	255921	853895	VP17 - A835 at Leanaig Junction
18	277985	853998	VP18 - B9039, approach to Ardersier
19	260729	859904	VP19 - Culbokie, Black Isle
20	252365	870918	VP20 - Glen Glass
21	269670	868889	VP21 - A817, Invergordon
22	231788	875289	VP22 - Tom Ban Mor
23	243211	883656	VP23 - Diebidale Ridge
24	250534	858555	VP24 - Knockfarrel
25	257824	845372	VP25 - A862 at Lentran
26	271455	847562	VP26 - A96 between Nairn and the Inverness Retail Park
27	280754	869026	VP27 - Suitors of Cromarty, Rosemarkie and Fort George SLA
28	272983	872261	VP28 - A9 East of Alness
29	266669	845126	VP29 - Viewing Tower at Inverness Castle
30	264288	873611	VP30 - Ardross Community Hall Southwest Facade
31	274368	844934	VP 31 - Culloden Battlefield

Note

The base map used is Ordnance Survey 1:50,000 Scale Raster. This product does not cover the full extent of the figure. Where gaps exist (open water), Ordnance Survey 1:250,000 Scale Raster has been included. The cartographic variation between datasets has not affected any analytical outputs or assessment findings.

DISCLAIMER :

1. Intensity values are unmitigated.
2. No receptor locations identified over 8.
3. Angles below -4 degree below 10 candela.
4. The ZTV analysis does not take into account the screening effect of vegetation, buildings and other surface features.
5. Predicted visibility based on a viewer eye height 2 m above ground.
6. Visibility calculated using Ordnance Survey Terrain 5 DTM on a 5 m Grid.
7. Effect of earth curvature and light refraction is included.

Figure Title
Aviation Lighting ZTV - All Turbines Lit

Project Name
Novar 1 Wind Farm Repowering

Project No./Filery ID
1620016706 / REH2023N04156

Date	Figure No.	Revision
September 2026	TA 5.5.1	1.0

Prepared By	Scale
RD	1:130,000 @A1

Client
nadara

RAMBOLL

1620016706-RAM-MA-IA-00081_AviationLightingZTV\ATturbine_07.aepx

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Coordinate System: British National Grid. Projection: Transverse Mercator. Datum: OSGB 1936.